SCIENCE.

FRIDAY, SEPTEMBER 4, 1885.

THE FUTURE OF THE LICK OBSERVATORY.

The history and description of this observatory, and the astronomical work already accomplished on Mount Hamilton, which we have given on a later page, lead very naturally to a statement of the chief advantages which, in so far as the observatory and its position and equipment are concerned, may reasonably be expected to accrue from this new departure in astronomical science.

The fact of mere elevation (less than a mile) above the sea-level will not, as is often supposed, greatly increase the apparent light of celestial objects, as the stars will appear to be only a small fraction of a magnitude brighter on the mountain than at the sea-level. But — what is incomparably more important — the gain in steadiness of the atmosphere at this elevated station has already been proven to be much greater than any one expected at the outset, and will enable the astronomer not only to make good use of a multitude of clear nights which, at less elevated stations, are found to be of little value, but also to elevate the grade of all his work to the last degree of precision. The perfection of this site for observations with the meridian circle — in fact, for all micrometric observation of whatever sort — will force the invention of better methods of eliminating personal and instrumental errors than we now possess. So far as the conditions of vision affect the stars' diurnal motion, the errors introduced in stellar co-ordinates will be so small that two or three observations of a star will suffice for the most accurate determination of its position. An enormous saving in the labor of observation and reduction is thus possible, if only the other errors can be eliminated with certainty from so small a number of observations. With regard to the influence of elevation upon the conditions of day-vision, it should be noted here that the testimony of Mr. Burnham in 1879, of Professor Holden in 1881, and of Professor Todd in 1882, is uniformly to the effect that the atmosphere above Mount Hamilton is quite as unsteady during the daytime as at other stations. This remark, however, must be understood as applying only to the period of the year from the middle of August to the middle of December, as no accurate observations upon this matter have been made in other months. It is very possible that the conditions of the atmosphere in late spring and early summer may give an entirely different experience at these seasons.

The elevation above a mile of the lower atmosphere becomes significant in another way, however, as it makes effectively available a much larger region of sky than can be commanded at other stations in a like latitude, where observations at zenith distances much greater than seventy degrees are usually not worth the making. Mr. Burnham directs attention to this fact, as affecting observations in that portion of the southern celestial hemisphere which is ordinarily inaccessible for observations of precision at our northern observatories. At the latitude of Mount Hamilton, the fifty-third parallel of south declination is about co-incident with the south horizon; and, out of forty-two new double-stars discovered by Mr. Burnham during his residence upon the mountain in 1879, twenty are between the thirtieth and fortieth parallels of south declination (that is, between limits of maximum altitude equal to twenty-three and thirteen degrees); and five of the new stars are between the fortieth and forty-fourth parallels, or between limits of maximum altitude equal to thirteen and nine degrees only. This important advantage will not be confined to the southern horizon only, but will duly influence all fields of astronomical inquiry where important observations have occasionally to be taken near other parts of the horizon.

The prevalence of violent winds on the summit, and particularly their effect upon the steadiness of the atmosphere, have not yet been thoroughly investigated. As a general rule, astronomers at ordinary elevations expect to find severe winds accompanied by atmospheric conditions which do not admit of satisfactory micrometric work. Mr. Burnham found that moderately strong winds did not seem to affect the optical steadiness of the atmosphere. A remarkable experience of my own on the mountain may be mentioned here. On the night of the 2d of December, 1882, when the wind was blowing steadily with such violence as to make it extremely hazardous to open the dome in the face of it, I found Jupiter and Saturn very unsteady and much blurred; but turning to Sirius, I found the companion an extremely conspicuous object, — in fact, the note in my observing-book is to the effect that the companion was "as readily seen as a satellite of Jupiter." So far as I am aware, this is a unique experience of the effect of severe wind upon the optical quality of the atmosphere.

The location of the observatory in a region which is entirely cloudless during the greater part of the year, constitutes an advantage which only those can fully appreciate whose work has suffered serious interruption from the lack of a continuously clear sky. Should those permanently in charge of the observatory find it desirable to continue observations throughout the period of five months known as the 'rainy season,' it would doubtless be found that the superior elevation would afford a clear sky throughout one-third to one-half of this period, and simultaneously with clouds and storms at stations lower down. During my own residence on the mountain in the latter part of 1882, and shortly after the beginning of the rainy season, this was frequently the case; and on two separate occasions we were favored with an uninterruptedly clear sky for more than seventy consecutive hours, being situate on an island in a sea of cloud which obscured every thing beneath the immediate summit. A series of excellent photographs of this cloud-sea was obtained, one of which is well reproduced in the illustration on p. 191. Ocean fogs rarely reach the elevation of the observatory. Mr. Burnham observed these fogs drifting in from the Pacific nearly every night at about the time of sunset. Their usual altitude was about two thousand feet, and they did not appear to affect the seeing.

The instrumental equipment of the observatory, although incomplete, is already an unusual one, and, in its final state, will surpass that of all other observatories. The instruments have been designed, constructed, and mounted in the most thorough manner; and particular care has been taken that all the movable portions of the buildings covering these instruments (always a source of unending trouble and vexatious delay to the astronomer) shall be so arranged and constructed as to cause a minimum of annoyance and interruption.

The great advantages arising from the observers' ability to reside near their instruments must not be overlooked here. A suitable dwelling-house for the observers has been provided in the immediate proximity of the instruments, so that all the time available for observatory work may be fully utilized.

The means of publication — a most important consideration in the management of a great observatory — has not escaped due notice. The legislature of California has already shown its entire appreciation of the observatory and its work, by the passage, at its last session, of a joint resolution providing for the issue of such reports, observations, and researches, as may, with the approval of the governor of the state, be submitted by the Lick trustees, or the regents of the university, for publication.

Finally, and most important of all, there is an assured endowment of generous proportions, the income from which is wholly available for the maintenance of the establishment, and the prosecution of its work. The considerate management of the trustees will enable them to complete the observatory at a cost not much exceeding three-fifths of the entire allotment of Mr. Lick's bequest for this purpose, and the remainder will constitute the permanent endowment-fund of the institution.

Fortune and necessity, however, do not fail to accompany this unique combination of opportunities with more or less of disadvantage. The unavoidable obstacles of the undertaking have been great, but they have also been surmounted. But the necessary expense of maintaining so large an establishment at so elevated a station, the cost of living, the social isolation of the astronomers, amounting to practical exile for months at a time when series of observations requiring uninterrupted attention are in hand, — these, and other obvious considerations, must be carefully considered by any one who attempts a fair estimate of the work which the Lick observatory is destined to accomplish. While it appears that the institution will be in a strong position to conduct and maintain a good degree of astronomical research with its own resources, there will be abundant field for prudent financiering in the management of its practical affairs. However, when the trustees are ready to resign the control of the observatory, the character of its instrumental and other equipment will be such that all increase of its permanent income, derivable from outside sources, will be wholly available for the pursuit of new and interesting lines of research. The nature of investigations of this sort enables the astronomer to make successful appeal for the funds necessary to carry them on; and the trustees have wisely refrained from equipping the observatory with any instruments and apparatus which will not be of immediate necessity in the conservative lines of astronomical inquiry.

DAVID P. TODD.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

A method for determining the unit of light.

IN all photometric work hitherto undertaken, one of the main difficulties has been to obtain a satisfactory standard of light, — one which will be always constant, and which can be accurately duplicated. Heretofore, all experiments in this direction have been failures. The plan here suggested contemplates, not the employment of a unit quantity of light, but the employment of a certain effect produced by that unit quantity as a standard. In other words, it makes not the light, but the photometer, the constant.

This photometer must, then, be some device for measuring radiant energy. But, for photometric purposes, we wish only to measure that portion of the energy which has a wave-length readily visible to the human eye. With the great differences in color of our modern sources of illumination, it is absolutely impossible to state an exact equivalence between the yellow light of a candle-flame, and the blue light of an electric arc. For really accurate work, we can compare only light rays of the same wave-length. As the human eye is most sensitive to light from that portion of the spectrum between the D and E lines, in the following plan I have selected that region of the spectrum to be used exclusively for the comparison of the brilliancy of the various lights. In all probability, the total brilliancy of an incandescent body does not increase in a ratio exactly proportional to the increase in brilliancy of the yellow rays; but this difference, within practicable limits, is probably so small as to be entirely negligable. And we have the advantage of being able to state an accurate arithmetical ratio between the lights, instead of what must be at best a mere general comparison of the relative effect of the two lights upon our eyes.

Briefly stated, then, the method I would suggest consists in moving the light to be measured towards the slit of a spectroscope, until a certain effect is produced upon a screen so placed as to receive the yellow rays. When this effect is produced, the spectroscope is receiving the standard amount of light from the source; and the brilliancy of the source can then be determined by measuring its distance from the slit.

In attempting to apply this method, the difficulty which at first arises is, to obtain an effect which can be measured with accuracy. By permitting the spectrum of a light to fall upon suitable screens, three classes of effects may be obtained; namely, heating, visual, and chemical. Of these, the second is evidently unsuited for the purpose of obtaining a standard. The third is too uncertain, and not susceptible of sufficient accuracy, so that the first alone remains. Of the two practicable heat methods of measuring radiant energy, the thermopile is the more sensitive; but the bolometer responds the quicker to changes of temperature, and has the narrower surface. The latter instrument has, therefore, been selected for this application of the method. The unexposed arm of the bolometer has a slight additional adjustable resistance thrown into its circuit, so that, when the instrument is not in use, the needle of the galvonometer will have a certain deflection dependent on the strength of the battery-current employed. When the light to be measured is placed in front of the slit of the spectroscope (which should be quite broad), the deflection will be diminished. As the light approaches the slit, the deflection will decrease, and finally become zero, at which time it is giving out the standard light. Its brilliancy can now be read off from its position upon a scale placed in front of the slit and parallel to the collimator.

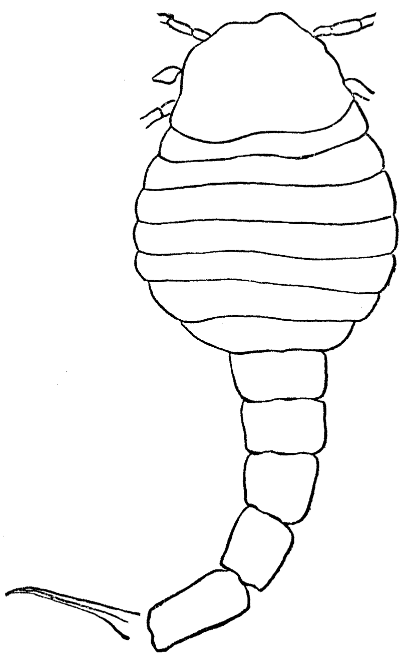
This photometer might also be used to adjust the position at which an incandescent electric or other lamp should be placed in order to furnish a constant supply of light. This source could then be used as a unit in an ordinary photometer.

WM. H. PICKERING.

An American Silurian scorpion.

The 'American scorpion' from the water-lime group of New-York State, described by Professor Whitfield on pp. 87, 88, is undoubtedly a young specimen of Eusarcus scorpionis (Grote and Pitt: Bulletin of the Buffalo society of natural sciences, vol. iii., pp. 1, 2), so named by an error, and which will be redescribed as Eurypterus scorpionis in the forthcoming vol. v. of the society's bulletin.

The enclosed is a sketch of the youngest specimen in my possession, drawn full size: the largest I have,



indicates an animal at least three feet long. There cannot be any doubt as to its zoölogical position; for the characteristics of the genus Eurypterus — eyes placed within the margin of the carapace, and a triangular spine as caudal appendage — can be distinctly identified.

All my specimens have been found in the water-lime group at Buffalo, associated with Eurypterus, Pterygotus, and Ceratiocaris.

JULIUS POHLMAN.

Buffalo, N.Y., Aug. 5.